

REMARKS

This is a full and timely response to the non-final Office Action mailed October 11, 2006, in which each of Applicants' Claims 1-21 was rejected. By way of this Response, Claim 13 has been amended. Currently, Claims 1-21 are pending and under examination. Reconsideration of Applicants' Application is respectfully requested in view of the following remarks.

I. Claims 1, 7-8, and 17 Rejected under 35 U.S.C. §103

On page 2, the Office Action rejects Applicants' Claims 1, 7-8, and 17 under 35 U.S.C. § 103(a) as being unpatentable over Ueno (US Pat No. 6,245,676) in view of Saka et al. (US Pat No. 6,476,921). With respect to Applicants' independent Claims 1 and 17, the Office Action states that the Ueno reference teaches each of the claimed steps with the exception of removing the copper and barrier layer with a single polishing platen.¹ The Office Action asserts that such a step is taught by the Saka reference and, therefore, that it would have been obvious to one of ordinary skill in the art to modify the CMP method of the Ueno reference to produce Applicants' claimed planarization method for the purpose of reducing the equipment needed to perform the CMP method.

Before a *prima facie* case of obviousness may be established under 35 U.S.C. § 103, three fundamental criteria that must be met. MPEP § 2142. First, the prior art references must teach or suggest all of the claimed limitations. Second, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Finally, there must be a reasonable expectation of success to combine the reference teachings. References failing to meet any one of these criteria may not be utilized to form the basis of a valid rejection under 35 U.S.C. § 103. As explained below, the Ueno and Saka reference fail to meet each of these three of the fundamental criteria and, consequently, cannot form the basis of a valid rejection to Applicants' Claims 1 and 17 under 35 U.S.C. § 103.

(1) The cited references fail to teach or suggest all of the claimed limitations.

On page 3, the Office Action acknowledges that the Ueno reference does not teach the step of removing the copper layer and the barrier layer with a single polishing pad. However, the Office Action asserts that the Saka reference teaches such a step at Column 4, Lines 29-56. Applicants respectfully disagree. This portion of the Saka reference generally describes the capabilities of the CMP machine shown in FIGs. 2 and 3. Specifically, the Saka reference explains that the illustrated CMP machine may be utilized to remove various materials overlaying the barrier layer and, also, that the CMP machine may be utilized to remove the barrier material itself. The cited passage does not discuss the process by which the CMP machine may remove the materials overlaying the barrier layer (e.g., the copper layer) or the barrier layer. Furthermore, the cited passage only utilizes the term “polishing pad” once and does not describe the manner in which the polishing pad is utilized.² The cited passage thus does not teach or remotely suggest the removal of the copper layer and the barrier layer *with a single polishing pad*. The remainder of the Saka reference is also silent as to the use of a single polishing pad to remove the copper layer and the barrier layer. Considering this, it should be appreciated that the Ueno reference and the Saka reference fail to teach or suggest all of the limitations recited in Applicants’ independent Claims 1 and 17.

(2) The prior art does not provide a suggestion or motivation to modify the reference or to combine reference teachings.

Applicants’ Claims 1 and 17 each recite the steps of (1) electrodepositing a metal/copper layer having a substantially planar upper surface, and (2) polishing the deposited layer on a single polishing pad. The cited references do not provide a suggestion or motivation to combine these claimed steps. With respect to the Saka reference, metal layer 13 (shown in FIG. 1A) does not have a substantially planar upper surface. With respect to

¹ Applicants assume that, by the term “polishing *platen*,” the Office Action intends the term “polishing *pad*” as Applicants’ Claims 1 and 17 each recite the step of “polishing.... on a single polishing *pad*”.

² Please see Column 4, Lines 33-34, which states that “[t]he platen carries a polishing pad 23 onto which polishing slurry is applied during the CMP process.”

the Ueno reference, it is unclear from FIG. 1(c) and the attendant description whether the upper surface of layer 37a is “substantially planar” as that term is defined in Applicants’ Paragraph 0016; however, it is clear that the Ueno reference does not teach or suggest the step of polishing the upper surface of layer 37a. To the contrary, the Ueno reference teaches the deposition of additional copper over the upper surface of layer 37a to form layer 37b, which is shown in FIG. 2(a)) as having a distinctly non-planar upper surface.³ It is this non-planar layer 37b that is polished to yield the workpiece shown in FIG. 2(b).

It should be appreciated from the foregoing that neither the Saka nor the Ueno reference expressly provides a motivation to combine the steps recited in Applicants’ Claims 1 and 17. However, Applicants are aware that the rationale to modify or combine the prior art need not be expressly stated in cited references, but may instead be reasoned from knowledge generally available to one of ordinary skill in the art at the time of the invention. MPEP § 2143.03. The strongest rationale for combining references is a recognition, expressly or impliedly in the prior art or drawn from a convincing line of reasoning based on established scientific principles or legal precedent, that some advantage or expected beneficial result would have been produced by their combination. MPEP § 2143.03 citing *In re Sernaker*, 702 F.2d 989, 994-95, 217 USPQ 1, 5-6 (Fed. Cir. 1983). The Office Action suggests that one skilled in the art would recognize the claimed combination of steps as providing the advantage of reducing the equipment necessary to perform the CMP process. Applicants disagree and respectfully submit that one skilled in the art would not have appreciated that such a combination of steps was suitable for performing CMP; as explained in the following section, at the time of Applicants’ invention, it was commonly believed that only a CMP process that employed multiple polishing pads was capable of planarizing a workpiece’s upper surface to industry standards.

³ See, for example, Column 10, Lines 43-48; Column 11, Lines 24-33; and Column 12, Lines 39-62.

(3) The prior art fails to provide a reasonable expectation of success.

As described in Applicants' Background, conventional methods of workpiece planarization involve numerous polishing steps and multiple polishing pads.⁴ Hard polishing pads are employed to remove the thick copper layer overlying the field region. As explained in Applicants' Paragraph 0023, Applicants discovered that multiple polishing pads are, in fact, not necessary to planarize the copper layer providing that, prior to planarization, the copper layer has a substantially planar upper surface and is relatively thin (i.e., does not have a thick overburden overlying the field regions of the dielectric layer). Stated differently, Applicants discovered that a single polishing pad could be utilized to remove the copper layer and the barrier layer and still yield a sufficiently planar surface. Applicants also discovered that a soft polishing pad could be utilized in lieu of the hard polishing pad previously thought necessary to achieve the desired planarization.

Thus, due to the belief that a single polishing pad was incapable of producing a sufficiently planar surface, one skilled in the art would not have had a reasonable expectation of success in polishing the deposited copper layer with a single polishing pad. The cited references do not contradict this. Accordingly, Applicants respectfully submit that the prior art does not provide a reasonable expectation of success in combining the steps recited in Applicants' Claims 1 and 17.

In view of the above, it should thus be appreciated that the Ueno and Saka references fail to meet *each* of the three fundamental criteria necessary to establish a prima facie case of obviousness against Applicants' independent Claims 1 and 17. Consequently, the Ueno and Saka references cannot render Applicants' independent Claims 1 and 17 obvious under 35 U.S.C. § 103. As no further rejections have been asserted against Claims 1 and 17, Applicants respectfully submit that independent Claims 1 and 17 are allowable.

Applicants' Claims 7 and 8 each depend from Applicants' independent Claim 1 and are thus believed allowable therewith.

II. Claims 2, 3, 9-11, 13, 14, 16, and 18-21 Rejected under 35 U.S.C. §103

On pages 3-8, the Office Action rejects Applicants' Claims 2, 3, 9-11, 13, 14, 16, and 18-21 under 35 U.S.C. § 103(a) as being unpatentable over the Ueno and Saka references discussed above in view of Hsu et al. (US Pub. 2003/0040188), Sinha et al. (US Pat. No. 6,551,935), and/or Mahulikar et al. (US Pat. No. 6,776,969). Applicants' independent Claim 13, in particular, is rejected under 35 U.S.C. § 103(a) as being unpatentable over the Ueno reference in view of the Saka reference and in further view of the Hsu et al. reference.

Applicants' independent Claim 13 recites steps similar to those recited in Applicants' independent Claims 1 and 17. Thus, Applicants' independent Claim 13 is believed to distinguish over the Ueno and Saka reference for the reasons discussed above in conjunction with independent Claims 1 and 17. Furthermore, the deficiencies pointed out above with respect to the Ueno and Saka reference also apply to the Hsu reference; e.g., like the Ueno and Saka references, the Hsu reference fails to teach the step of removing the copper layer and the barrier layer with a single polishing pad. This notwithstanding, Applicants have amended independent Claim 13 to further distinguish over the cited reference and to expedite prosecution. Applicants' amended independent Claim 13 now recites the step of chemical mechanical polishing the layer comprising copper and the barrier layer on a single *soft* polishing pad. This feature is not taught or suggested by the cited references, including the Hsu reference.⁵ Furthermore, one skilled in the art would not have recognized a reasonable expectation of success in utilizing a soft polishing pad to remove the copper layer and the barrier layer because, at the time of Applicants' invention, it was commonly believed that a hard polishing pad was necessary to achieve a substantially planar surface.⁶ For these reasons, and for those explained above, Applicants respectfully submit that amended independent Claim 13 is allowable.

Applicants' Claims 2, 3, 9-11, 14, 16, and 18-21 each depend from Applicants' independent Claim 1, 13, or 17 and are thus believed allowable.

⁴ These steps may include a first rapid removal / hard polishing step to remove the bulk of the excess metal, a second lower pressure / hard polishing step to remove a final portion of the excess metal, a third polishing step to remove the barrier layer, and, perhaps, a final buffing step.

⁵ The Hsu reference merely teaches the use of a soft polishing pad; it does not teach the step of performing CMP with a single soft polishing pad.

III. Claims 4-6 and 15 Rejected under 35 U.S.C. §103

On page 7, the Office Action rejects Applicants' Claims 4-6 and 15 under 35 U.S.C. § 103(a) as being unpatentable over the Ueno reference in view of the Saka reference, the Hsu reference, and the Mahulikar reference. Applicants' Claims 4-6 each depend from Applicants' independent Claim 1 and are consequently believed allowable therewith. Similarly, Applicants' Claim 15 depends directly from Applicants' independent Claim 13 and is thus believed allowable therewith.

IV. Prior Art Made of Record but Not Relied Upon

After reviewing the references made of record but not relied upon, Applicants believe that these references, whether taken singularly or in combination, do not form the basis of a valid rejection to claims.

V. Conclusion

In view of Applicants' forgoing amendments and remarks, it is respectfully submitted that the rejections set-forth in the Office Action dated October 11, 2006 have been overcome. Accordingly, Applicants respectfully submit that the Application is now in condition for allowance, and such allowance is earnestly requested. Should the Examiner have any questions or wish to further discuss this application, Applicants request that the Examiner contact the Applicants' attorneys at (480) 385-5060. If for some reason Applicants have not requested a sufficient extension and/or has not paid a sufficient fee for this Response and/or for the extension necessary to prevent abandonment on this application, please consider this as a request for an extension for the required time period and/or authorization to charge Deposit Account No. 50-2091 for any fee which may be due.

Dated: 1/4/07

Respectfully submitted,

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⁶ Please see Applicants' Paragraph 0023.